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COMPARATIVE EVALUATION OF GROWTH PARAMETERS, GERMINATION PERCENTAGE AND SEEDLING VIGOUR OF TOMATO AND POTATO SEEDLINGS CO INOCULATED WITH PSB, KMB AND KSB ISOLATES UNDER GREEN HOUSE CONDITION

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ABSTRACT

A comparative study was conducted to evaluate the growth parameters and the germination of two Solanaceous crop tomato and potato under green house condition in seedling trays. The aim of this study was mainly focused to evaluate the response of the KSB isolates along with PSB and KMB on germination and growth. The experiments were conducted in seedling trays containing coco pith and vermi compost at 2:1 ratio. Three Potassium Solubilising Bacterial (KSB) isolates along with Phosphorus solubilising bacteria (PSB) and Potassium mobilising bacteria (KMB) were inoculated to the trays with four replication for each treatment. Control has been kept uninoculated. Results revealed that, significant differences were observed in different treatments in regard to seedling growth parameters. Among the nine treatments, T_3 showed highest germination percentage in tomato seedlings. Growth parameters was also highly influenced in tomato seedlings by the application of the treatments T_2, T_7, T_8 and T_9 in tomato; whereas in potato, T_3 recorded highest growth along with tuber initiation followed by T_7, T_9 and T_8 respectively. In case of tomato, individual application of Phosphorus solubilising bacteria (PSB) and Potassium mobilising bacteria (KMB) showed equally good results with coinoculated treatments, whereas in case of potato, results were observed significantly highest in seedlings treated with Potassium mobilising bacteria (KMB) compared to Phosphorus solubilising bacteria (PSB). Among the three KSB isolates, best results were found in T_3 and T_2 in both tomato and potato compared to T_1. Co inoculation of KSB isolates also recorded significant results in tomato seedlings. Initiation of number of potato tubers were also observed highest in T_3 and T_9 followed by T_2, T_4 and T_7

KEYWORDS: PSB, KSB, KMB, Seedling Growth, Green House & Biofertilizers

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Original Article

INTRODUCTION

Tomato and potato both the crop belongs to the family Solanaceae, are major crops grown worldwide along in India. Tomato (*Lycopersicumesculentum* L.) is an important commercial vegetable cultivated widely in India as well as throughout the world in field and green houses. Tomatoes are the dietary source of antioxidant *viz.,* lycopene, lutein and beta carotene which has lot of health benefits including reduced cancer and heart diseases. It is also rich in vitamin C, vitamin K, folate and potassium. Because of its high nutritive value and versatile usage in culinary tradition made tomatoes commercially grown economically significant crop (Albaho*et al.,* 2009) throughout the world.

Potato (*Solanumtuberosum*), important tuber food crop of Solanaceae family is grown all over world. It is an excellent source of Vitamin C as well as potassium and Vitamin B6. It is free from fat, cholesterol and sodium. In India, potato is cultivated in both rabi and khariff season.

Potassium is considered as a third essential nutrients after Nitrogen and Phosphorus required for the plant growth and is directly involved in different vital growth metabolism and enzyme activation. Potassium solubilizing bacteria are the potential microorganisms which can solubilize the insoluble forms of potassium minerals and make available to the plants to absorb (McAfee 2008; White and Karley 2010).

Rhizospheric microorganisms has the capability of solubilizing the nutrients from insoluble minerals and make readily available to the plants for growth and yield and they also plays a vital role in natural P and K cycle (Diep and Hieu, 2013). Potassium solubilizing bacterial isolates were isolated from banana rhizosphere soil amended with two different potassium bearing minerals *viz*., orthoclase feldspar and muscovite mica. Three efficient isolates were selected for the study.

Phosphate solubilizing bacteria are the beneficial microorganism that effectively solubilizes the mineral P from the organic Phosphorus compounds which are not readily available to the plant for their growth and nutrition. Application of PSB effectively results in growth promoting attributes of the plants.

To achieve great quality and high yielding crops, it is necessary to produce healthy, good quality potential seedlings. Germination of a seed is a very important factor to produce healthy seedling, as the whole life of the plant depends on the germination rate. To achieve healthy, potential and high yielding seedlings under green house condition factors involved are growth medium and good quality seeds. Growth medium to grow seedlings under green house should have certain properties which will allow the seed to germinate faster and grow well, *viz*., water holding capacity, proper aeration with adequate nutrition supply (Khobragade *et al.,* 1997: Hartmann *et al.,* 2011) when applied in soil less substrates. Seed germination and seedling growth was significantly influenced by different treatments. Germination percentage was highly influenced by the application of KSB isolates and PSB respectively. Growth parameters *viz*., shoot length, root length, number of leaves and tuber formation in potatoes was influenced by the application of KSB isolate SDM.

Potassium solubilizing bacteria and phosphorus solubilizing bacteria both are equally important and beneficial microbes for the development of crop growth. Hence, the present study was undertaken to evaluate the effect of both PSB and KSB isolates on seed germination, seedling production and growth parameters of solanaceous crop tomato and potato.

MATERIALS AND METHODS

The experiments were carried out at Department of Agricultural Microbiology, UAS, GKVK, Bengaluru, under green house condition.

Preparation of Seedling Tray

Seedling tray containing 18 cavity of dimension measured 49 cm x 25.5 cm x 8 cm was selected for the experiment. Well decomposed coir pith and vermicompost @ 2:1 ratio was used as a growing medium for both the crops. Two third of each cavity of the tray were filled with the growing medium and watered before sowing the seeds.

Sowing of Seeds in Seedling Tray

Tomato seeds were soaked overnight in a petri plate before sowing to the seedling trays. 4-5 seeds were placed in each

cavity. During sowing, broth cultures of PSB, KMB and KSB isolates were applied @ 10 ml per cavity. After 4-5 days of sowing, tomato seeds were found sprouted with two leaf stage.

Single seed potato was placed per cavity of the seedling trays; during sowing, broth cultures of PSB, KMB and KSB isolates were applied @ 10 ml per cavity, similar to tomato seeds. After 3-4 days, sprouting was observed.

Depending on the moisture content in the trays, seedlings were watered in regular intervals. Germination percentage of seedlings were calculated by using the following formula (Atif *et al.,* 2016).

Preparation of Broth Culture

Phosphorus solubilizing bacterial (PSB) cultures were grown on Pikovskaya media and sub cultured in regular intervals, Potassium mobilizing bacteria (KMB) were grown and maintained on GYCA (Glucoseyeast extract calcium carbonate agar) media. Potassium solubilizing bacterial (KSB) isolates were isolated and grown on Aleksandrov medium. All the bacterial cultures were maintained regularly and used for the application in the seedling trays under green house condition. PSB, KMB and KSB bacterial isolates were applied individually and in consortia. Four replications were kept for each treatments. Control has been kept as uninoculated.

RESULTS AND DISCUSSIONS

Germination Percentage

Difference in percentage of seedling germination was observed with application of different treatments. Germination percentage was calculated in tomato seedlings after 5 days of sowing. The data represented in Table 1 showed that highest percentage of germination was observed in T_3 followed by T_1, T_8 and T_9.

Table 1: Germination Percentage Influenced by different Treatments in Tomato Seedlings under Green House Condition

Sl. No.	Treatment	Germination Percentage %
1.	T_1	90.33^{b}
2.	T_2	75.00^{e}
3.	**T_3**	95.16^{a}
4.	T_4	80.66^{d}
5.	**T_5**	61.00^{h}
6.	**T_6**	64.83^{g}
7.	**T_7**	70.46^{f}
8.	**T_8**	90.50^{b}
9.	**T_9**	88.50^{c}
10.	Control	51.83^{i}

S.E.M.: 0.34, LSD (p<0.01): 1.36, C.V. (%): 0.76

Figure 1: Tomato Seedlings Grown under Green House Condition.

Effect of different Bacterial Cultures on Growth Parameters of Tomato Seedlings

Growth parameters were also significantly influenced with the application of PSB, KMB and KSB isolates. Among the nine treatments, T_7 i.e. consortia of KSB bacterial isolates(SAF+SBF+SDM) showed maximum shoot length, root length, number of leaves and fresh weight in tomato seedlings (Table 2). Next best result was observed in T_3 followed by T_5, T_8 and T_9.

Table 2: Growth Parameters of Tomato Seedlings under Green House Condition (30 days)

Sl. No	Treatment	Growth Parameters					
		Shoot Length	Root Length	Fresh Weight	Dry Weight	No of Leaves	
						Composite	Individual
1.	**T_1**	25.50^{a}	28.00^{ab}	4.83^{d}	1.16^{bcde}	4.00^{a}	14.00^{a}
2.	**T_2**	25.83^{a}	25.16^{b}	9.46^{c}	0.87^{ef}	4.00^{a}	12.33^{a}
3.	**T_3**	26.50^{a}	19.00^{b}	10.33^{bc}	1.39^{abc}	4.00^{a}	17.33^{a}
4.	**T_4**	27.40^{a}	29.06^{ab}	10.16^{bc}	1.22^{abcd}	4.33^{a}	17.66^{a}
5.	**T_5**	24.50^{a}	30.83^{ab}	10.73^{bc}	1.28^{abc}	4.00^{a}	17.33^{a}
6.	**T_6**	27.00^{a}	27.50^{b}	11.23^{ab}	1.45^{ab}	4.00^{a}	15.00^{a}
7.	**T_7**	26.60^{a}	44.50^{a}	12.53^{a}	1.52^{a}	4.00^{a}	16.66^{a}
8.	**T_8**	26.00^{a}	23.93^{b}	10.66^{bc}	1.08^{cdef}	4.00^{a}	17.66^{a}
9.	**T_9**	26.00^{a}	23.93^{b}	10.00^{bc}	0.90^{ef}	4.00^{a}	16.00^{a}
10.	**Control**	19.00^{b}	19.66^{b}	2.84^{e}	0.77^{d}	3.33^{a}	11.33^{a}
SEM		0.97	3.86	0.35	7.36	0.23	1.87
LSD(p<0.001)		3.92	15.53	1.43	0.29	0.94	7.54
C.V.		6.64	24.61	6.66	10.96	10.29	20.89

Number of leaves was observed highest in T_4. Similar results were found by (Sahni *et.al.,*2008) showed significant effect on growth parameters when combined application of coir pith and vermi compost was given.

As, phosphate solubilizing bacteria (PSB) is a potential biofertilizer, it is significantly used in organic agriculture due to its diverse characteristics as a growth enhancer. It promotes growth not only by releasing the mineral phosporus by solubilization and making readily available to the plants, it also has the ability to secrete growth hormones like auxins and cytokinins. Positive influence in growth may be due to the easily available of mineral P as well as release of growth hormones. Similar results were found by (Pathak *et.al*.,2017) showed in their study that significant levels of growth enhancement was observed by the isolates of Phosphate solubilizers in tomato seedlings in green house.

Table 3: Effect of different Bacterial Cultures on Growth Parameters of Potato Seedlings

Sl. No.	Treatment	Shoot Length	Root Length	No of Leaves	Fresh Weight	Dry Weight	No. of Potato Tubers Initiated
1.	**T_1**	49.66^{cd}	29.33^{bc}	54.33^{b}	37.00^{a}	5.36^{b}	1.33^{c}
2.	T_2	51.00^{bcd}	25.83^{cde}	57.00^{b}	22.46^{cd}	3.50^{d}	1.66^{c}
3.	**T_3**	60.00^{a}	28.60^{bcd}	79.00^{a}	34.93^{ab}	6.53^{a}	3.66^{ab}
4.	T_4	50.00^{cd}	25.00^{def}	61.33^{b}	24.93^{c}	4.66^{c}	2.00^{bc}
5.	T_5	45.33^{de}	23.00^{ef}	49.33^{b}	13.66d^{e}	3.00^{e}	0.66^{c}
6.	T_6	43.00^{e}	23.66^{ef}	53.66^{b}	31.33^{abc}	6.36^{a}	2.00^{bc}
7.	**T_7**	56.66^{ab}	31.33^{b}	59.66^{b}	32.23^{abc}	5.26^{b}	4.00^{a}
8.	**T_8**	51.00^{bcd}	28.66^{bcd}	51.33^{b}	39.60^{a}	5.53^{b}	4.00^{a}
9.	**T_9**	52.66^{bc}	39.66^{a}	50.66^{b}	26.13^{bc}	5.20^{b}	4.66^{a}
10.	**Control**	32.66^{f}	21.00^{f}	30.33^{c}	10.23^{e}	1.26^{f}	0^{c}
SEM		1.57	0.9	13.57	2.22	0.11	0.43
(p<0.01)		5.53	3.69	13.47	8.96	0.44	1.74
C.V.		4.83	5.75	11.31	14.16	4.13	31.3

Data pertaining to growth parameters of potato are presented in Table 3, showed differences in growth attributes

viz., shoot length, root length, number of leaves, fresh weight and tubers initiation in each treatments. Potassium mobilizing bacteria (KMB) and Potassium Solubilizing bacterial isolate (KSB) has significantly influenced the growth of potato seedlings. This may be due to the more availability of nutrients (Kumar and Mangal, 1997 and Indiresh*et al.*, 2003). Maximum number of tubers was initiated in T_8 and T_9 KMB and PSB bacterial cultures followed by KSB (T_3) isolate. Shoot length, root length and number of leaves were also found highest in KMB, and KSB treatments.

Figure 2: Potato Seedlings under Green House.

Figure 3: Potato Seedlings after Harvest (30 days).

CONCLUSIONS

The present study was focused on seedling growth and vigour of two solanaceous crops grown under green house condition. Both the crops were treated with PSB, KMB and KSB isolates and the crops showed significant response to all the biofertilizers. Growth media also had effect on the growth of seedlings has been studied and observed (Vivek and Duraisamy 2017) where coir pith was found to be an effective growth media for growing of tomato seedlings under green house condition. Similar results were also recorded stating that combined application of coir pith and vermi compost showed significant results in regard to nutritional factors and physical conditions in seedling growth (Sahni et.al, 2008). Germination percentage was highly influenced by the application of different biofertilizers. With regard to growth parameters in both tomato and potato seedlings, KSB isolates and PSB showed almost equal results in shoot length, root length, number of leaves, fresh weight and tuber initiation in potatoes. Hence, it can be concluded that biofertilizers are very potential in growth promotion under green house condition as well as in field application.

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AUTHORS PROFILE

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Research Experience:

- Research experience in the field of Organic Farming and Biofertilizers, using Microbial and Biotechnological techniques, Field and lab experiments.
- Experience in Plant Tissue Culture
- Undergone Training Programme on DNA Fingerprinting and Molecular Characterization.

  She also contributed in publish of more than six research articles.

Dr. M. K. Shivaprakash

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Post Doctoral Research

Department of Biochemistry, Indian Institute of Science, Bangalore, Karnataka

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Awards / recognitions

1. Appreciation Award in Recognition of Dedicated Services as a Teacher by Rotary, Bangalore, South and Karnataka Civil Defence Corps (From Governor) on 28th September, 2013 in Bangalore

2. Dr. B. P. Pal's Prize for securing highest Grade Point Average from among M.Sc (Agriculture) Graduates in Agricultural Microbiology during the year 1982.Recognitions:

Recognitions

Served as Technical Officer in the Directorate of Postgraduate Studies, UAS, GKVK, Bangalore from 2007 to 2011.

Served as Principal Investigator and Head of Research Institute of Organic Farming (RIOF), Directorate of Reseach , UAS, GKVK from 2011 to 2012 for one year.

Has been serving as Professor and University Head, Department of Agricultural Microbiology from 01.06.2012 to 31.05.2015.

Has been serving as Scheme Head of "Popularization of Biofertilizers and Quality control Laboratory", Dept. Of Microbiology, UAS, GKVK, Bengaluru from 16.01.2013 till date.

Has been serving as Member of Board of Studies UG and PG programme studies since 2012

Served as Coordinator and Nodal Officer of ICAR-JRF Coaching for Final BSc (Agri) Students from academic Year 2012-13 till date.

Has been serving as the Head of Scheme on "Popularization of Biofertilizers and Quality control " since 16.01.2013.

Member of organizing committee of National Science Congress held held during March 2017

Serving as Vice President of Agricultural Faculty Club, College of Agriculture , UAS, GKVK.

Major scientific achievements:

Academically, I am specialized on Nitrogen Fixing Cyanobacteria. Both my Masters and Doctoral Degree Research work was on Nitrogen Fixation. Some of the important achievements are as below:

I along with Dr. K. ShivappaShetty was instrumental in establishing a production units of CyanobacterialBiofertilizer and Azolla during 1984-85.

We undertook work in Indo-US project Stem Nodulating Bacteria and established seed production unit for Sesbaniarostrata during 1986-89.

I was involved in establishing a permanent Mushroom Production Laboratory in GKVK campus during 1995-96.

I was involved in establishing Cyanobacterial Research Laboratory where we had good collection of Spirulina species.

I was involved in establishing a separate Biocontrol Laboratory to facilitate research on Biocontrol of Soil Borne and Aerial diseases of crop plants.

In the last eight years, I have handled several externally funded projects on diverse topics including Biocontrol, Microbial inoculants for wetland rice, Production and promotion of ArbuscularMycorrhizal Fungi and Azolla in agriculture.

Presently, as the Head of the Project of "Popularization of Biofertilizers and Quality control Laboratory" our interest is on production stratergy for various Liquid and carrier based biofertilizers to meet the needs of farming community and established a Culture Collection of Agriculturally important Microorganisms for the benefit of Research workers.